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Authors

Solis, Michael
Vaughn, Sharon
Stillman-Spisak, Stephanie J
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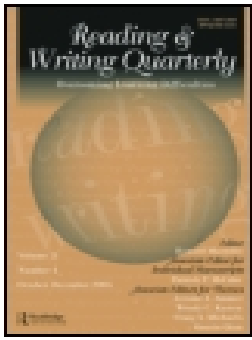
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Effects of Reading Comprehension and Vocabulary Intervention on Comprehension-Related Outcomes for Ninth Graders With Low Reading Comprehension

Michael Solis^a, Sharon Vaughn^b, Stephanie J. Stillman-Spisak^b, and Eunsoo Cho^c

^aUniversity of California Riverside, Riverside, California, USA; ^bThe University of Texas at Austin, Austin, Texas, USA; ^cMichigan State University, East Lansing, Michigan, USA

ABSTRACT

This experimental study examined the efficacy of a multicomponent reading intervention compared to a business-as-usual comparison condition on the reading comprehension and content area vocabulary outcomes of adolescent students with low reading comprehension. We randomly assigned 9th-grade students with low reading comprehension to a researcher-provided intervention ($n = 51$) or a business-as-usual comparison ($n = 49$) group. Reading interventionists provided weekly instruction for 2 semesters ($M = 114$ hr) to small groups of students ($M = 5$). We estimated intervention effects for each outcome measure using repeated measures analyses of covariance (ANCOVAs) for measures of reading and vocabulary. Results indicated statistically significant differences between students in the intervention and comparison conditions on measures of vocabulary and on the Test of Sentence Reading Efficiency and Comprehension (TOSREC) and no differences on the Woodcock–Johnson III Passage Comprehension subtest. Repeated measures ANCOVAs indicated large effect sizes on vocabulary measures between intervention and comparison students on multiple-choice and free response items ($\eta_p^2 = .16$ and $.19$, respectively) and small effect sizes on the TOSREC ($\eta_p^2 = .02$).

Many students entering high school are not adequately prepared to read complex text and continue to struggle with reading comprehension, which creates greater difficulty meeting the demands of content areas courses (Kamil et al., 2008). The implementation of state standards with high expectations for reading comprehension, including the Common Core State Standards, places more emphasis on students' understanding of increasingly complex text as a mechanism for acquiring content knowledge (www.corestandards.org). According to the most recent National Assessment of Educational Progress (United States Department of Education, 2015), approximately 64% of eighth graders were unable to read and comprehend text at the proficient level, which may impact success in college and career readiness (Carnegie Council on Advancing Adolescent Literacy, 2010). Most high schools have not adequately met the needs of ninth graders with low reading comprehension (Lang et al., 2009).

The severity and nature of reading problems for adolescents

To address the needs of adolescents with reading problems, the severity of the gap in performance compared to their typically performing peers and specific areas of need must be considered.

Hock et al. (2009) investigated the component skill profiles of adolescents with reading problems ($N=345$) by assessing the domains of word level, fluency, vocabulary, and comprehension in comparison to a sample of proficient readers. The study reported that 61% of students with reading problems had large deficits for all reading domains assessed (see above). On average the adolescents with reading problems scored 1 *SD* below the mean in all domains and between 20 and 25 standard score points below the proficient reader group. Although the largest gaps were in fluency and comprehension, there were also significantly large deficits within the word-level domain for 61% of students with reading problems (Hock et al., 2009). These findings are similar to other studies that have reported that between 49% (Catts et al., 2006) and 67% (Leach, Scarborough & Rescorla, 2003) of struggling readers have word-level reading deficits (Catts et al., 2006).

Through statistical models Cromley and Azevedo (2007) examined the relative relation of multiple components to reading comprehension. Their model included five components: background knowledge, word fluency, vocabulary, strategy use, and inferential comprehension. Based on their best fitting model for students identified as having reading problems (i.e., those falling below the 30th percentile), Cromley and Azevedo (2007) concluded that interventions for this subpopulation should focus on building background knowledge and vocabulary as a means of improving reading comprehension.

An investigation by Oslund, Clemens, Simmons, Smith, and Simmons (2016) used path analysis to examine the direct and indirect influences of vocabulary on reading comprehension. The sample included seventh and eighth graders from low socioeconomic backgrounds. Findings from this investigation indicated that vocabulary and inferential comprehension had the largest direct effects on reading comprehension. Vocabulary also had indirect effects on comprehension through sentence comprehension efficiency and inferential comprehension (Oslund et al., 2016). These empirical studies and statistical models of reading comprehension provide evidence of the problem areas of reading performance for adolescents with reading problems. To address these needs, experts should consider interventions with high levels of intensity (i.e., longer durations) that take into account the components of building background knowledge, vocabulary, text-based strategies, word fluency, and inferential comprehension.

Intensive reading interventions

The idea of intensive interventions has been conceptualized as increased intensity through the use of smaller groups and interventions that take place for long durations of time (Danielson, Zumeta-Edmonds, Fuchs, & Fuchs, 2016). Within the literature the construct of intensive interventions has been operationalized primarily through consideration of the number of sessions being provided (between 75 and 100) with consideration of the grade levels under investigation (Wanzek & Vaughn, 2007; Wanzek et al., 2013). To situate this particular investigation, we review the differences in findings for students in kindergarten–Grade 3 compared to those in Grades 4–12.

Wanzek and Vaughn (2007) conducted a meta-analysis of intensive reading interventions for students in kindergarten–Grade 3 that provided 100 or more sessions. Another meta-analysis by Wanzek et al. (2013) investigated intensive reading interventions for students in Grades 4–12 that provided 75 or more sessions. At the elementary level, the mean effect sizes across the domains of word reading, fluency, and comprehension for kindergarten–Grade 3 ranged from 0.34 to 0.56. With older students, mean effect sizes across the same three domains for Grades 4–12 ranged from 0.09 to 0.20. A comparison of findings across these different age ranges further exemplifies the challenges faced in remediating reading problems among adolescents. Clearly, the effects of intensive interventions for older students are much smaller compared to those for early elementary students. What can be gleaned from the body of research focused on Grades 4–12? Overall, the majority of these studies utilized multicomponent interventions. Other single-component

treatments included phonics instruction, visual imagery, self-questioning, paraphrasing, and inference instruction. Also of importance is that only one study had a participant sample of high school students (Lang et al., 2009). This meta-analysis provides further evidence of the dearth of research conducted with struggling readers in high school, especially research on intensive interventions using smaller groups and provided for longer durations.

In further consideration of the literature base on reading interventions for adolescents, we also reviewed a recent meta-analysis representing treatments of varying durations of implementation provided for struggling readers in the upper grades (Scammacca, Roberts, Vaughn, & Stuebing, 2015). This investigation also reported relatively few studies conducted with high school students. According to Scammacca et al. (2015), over the past decade only five studies of high school struggling readers have been conducted in the United States (Harris, Schumaker, & Deshler, 2011; Lang et al., 2009; McCallum et al., 2011; Penney, 2002; Wexler, Vaughn, Roberts, & Denton, 2010). All but one of these studies provided fewer than 25 hr of intervention instruction (Harris et al., 2011; McCallum et al., 2011; Penney, 2002; Wexler et al., 2010) and focused on single components of reading instruction such as word study (Penney, 2002), fluency (Wexler et al., 2010), vocabulary (Harris et al., 2011), or comprehension (McCallum et al., 2011). Only Lang et al. (2009) provided a multicomponent intervention for 90 min per day over a 9-month period and found no statistically significant differences in reading comprehension between struggling readers in the treatment and comparison conditions.

In more recent studies of intensive interventions for adolescents, students in middle school and high school have received treatments of long durations through specialized content area classes (Swanson et al., 2016) or provided as elective courses (Solis, Vaughn, & Scammacca, 2015). Swanson et al. (2016) randomly assigned students to comparison and treatment conditions over one school year. The treatment combined content area social studies and reading comprehension intervention for eighth graders identified as below-average readers. The components of the intervention included comprehension canopy, essential words, warmup, critical readings, and team-based learning comprehension checks and knowledge application activities. The treatment condition ($n = 45$) outperformed the comparison condition ($n = 33$), with statistically significant differences in knowledge acquisition (effect size = 0.35), content reading comprehension (effect size = 0.59), and vocabulary recall (effect size = 0.65). However, there were no statistically significant differences between the treatment and the comparison condition on a standardized measure of reading comprehension.

Working with a participant sample of ninth graders with adequate decoding and low comprehension, Solis et al. (2015) provided an intervention as an elective course. The multicomponent intervention was provided for 90-min time blocks for approximately 80 sessions over one school year. Intervention components included vocabulary/concept instruction, text-based instruction, grammar print structures, complex language structures, and inference reading drills. No statistically significant differences were detected on standardized measures of reading comprehension between the treatment and comparison conditions (Solis et al., 2015). However, a secondary analysis comparing students identified as high decoders to low decoders indicated a statistically significant interaction between treatment condition and decoding ability in support of the treatment being differentially beneficial for students with higher decoding skills. Solis et al. (2015) concluded that adolescents with reading problems might also require an additional component focused on word study.

Conceptual framework

The simple view of reading (SVR; Gough & Tunmer, 1986) and the construction-integration model of reading comprehension (Kintsch, 1994; Kintsch, 2004; van Dijk & Kintsch, 1983) framed the conceptualization of this intervention. The SVR assumes reading comprehension to be the product of word reading and linguistic understanding. Because reading comprehension is a

complex process requiring the integration of many processes, including background knowledge, vocabulary, attention, memory, and word reading, missing any of these contributes to a lack of understanding (Perfetti, Landi, & Oakhill, 2013). Taking into account the complexity of the linguistic understanding component of the SVR, we further conceptualized that portion of the intervention considering the construction-integration model of reading comprehension (Kintsch, 1994; Kintsch, 2004; van Dijk & Kintsch, 1983). This model postulates three levels of text comprehension: surface level, propositional level, and situation level. Surface-level understanding is thought of as basic understanding or decoding of letters and words prior to the propositional level, which is thought of as where understanding or decoding of the meaning of the words takes place. The situation level, often referred to as the situation model, is where the reader connects the meaning of the text with prior knowledge to form a deeper conceptual understanding of the content. Readers who construct an accurate understanding at the propositional level may have accurate recall of text information and may be able to identify main ideas within the text (Kintsch, 1994). However, Kintsch (1994) suggested that understanding at the propositional level is insufficient for learning from text:

Learning from a text implies that one is able to use the information provided by the text in other ways, not just for reproduction ... One can infer new facts from the information in the text, use it in conjunction with previous knowledge to solve novel problems, and integrate it with what is already known. (p. 294)

We conceptualized the components of the linguistic ability portion of the intervention as providing supports across all three levels of the construction-integration model.

Design and research questions

This experimental study was designed to investigate a 1-year reading intervention provided as an elective course compared to a business-as-usual (BAU) comparison condition in which students participated in electives provided by the schools. Participating school districts requested that we maximize the number of students participating in the intervention condition. Therefore, after the initial sample was identified, we blocked on schools ($N = 5$) and randomized students at a 2:1 ratio favoring the intervention condition. To address the need for improved content area text comprehension, we designed a reading intervention aligned with content area topics in social studies and science for target students performing 0.5 *SD* or lower in comprehension compared to the mean performance of a normative sample (MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2007). We hypothesized that students assigned to the intervention would demonstrate gains in reading and vocabulary outcomes on researcher-based and standardized reading assessments. The research questions were as follows: To what extent does a reading comprehension and vocabulary learning multicomponent intervention contribute to improved vocabulary outcomes? To what extent does the multicomponent intervention contribute to improved reading comprehension outcomes?

Method

Participants

School sites

This study was conducted in five diverse high schools in two near-urban school districts in the southwestern region of the United States. In the five schools sampled, the population of students was 42.3% Hispanic, 23.7% African American, 24.9% Caucasian, 5.2% Asian, 3.35% two or more races, and 0.6% Native American or Pacific Islander. The average percentage of students reported as economically disadvantaged was 52.7% across the participating schools. According to state accountability reports, all schools were rated Academically Acceptable for the school year in the study took place.

Table 1. Demographic data and pretest scores.

Variable	Comparison (<i>n</i> = 40)		Intervention (<i>n</i> = 51)		Total (<i>n</i> = 91)		
	<i>n</i>	%	<i>n</i>	%	χ^2	<i>n</i>	%
Gender					0.22		
Male	16	40	22	43.14		38	41.76
Female	24	60	27	52.94		51	56.04
Missing			2	3.92		2	2.20
Race							
Hispanic	25	62.50	29	56.86	0.3	54	59.34
African American	8	20.00	11	21.57	0.03	19	20.88
Caucasian	11	27.50	13	25.49	0.05	24	26.37
Asian American	2	5.00	1	1.96	0.65	3	3.30
Native American	4	10.00	6	11.76	0.07	10	10.99
Free or reduced lunch					0.03		
No	10	25.00	12	23.53		22	24.18
Yes	30	75.00	39	76.47		69	75.82
Limited English proficient					1.97		
No	27	67.50	41	80.39		68	74.73
Yes	13	32.50	10	19.61		23	25.27
SPED					2.78		
No	31	77.50	46	90.20		77	84.62
Yes	9	22.50	5	9.80		14	15.38
Variable	Comparison (<i>n</i> = 40)		Intervention (<i>n</i> = 51)		Total (<i>n</i> = 91)		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>M</i>	<i>SD</i>
Age	14.89	0.58	14.98	0.65	0.46	14.94	0.62
Word reading							
TOWRE	81.78	11.66	84.98	11.11	1.79	83.57	11.40
Comprehension							
WJ-PC	74.88	12.27	79.04	11.09	2.88	77.21	11.74
TOSREC	81.78	11.66	84.98	11.11	0.93	83.57	11.40

Note. *p* values for all chi-square and *F* statistics were all above .05. TOWRE = Test of Word Reading Efficiency; WJ-PC = Woodcock-Johnson III Passage Comprehension subtest; TOSREC = Test of Silent Reading Efficiency and Comprehension; SPED: Special Education.

Participants

The district required that we screen students for eligibility for the study at the end of their eighth-grade year so that student schedules could be finalized prior to the start of ninth grade. The initial sample of students was identified and randomized within each school at a ratio of 2:1 in favor of the intervention condition during the spring semester of the students' eighth-grade year. At this point in the study the sample consisted of 120 students (80 intervention, 40 comparison). At the start of students' ninth-grade year the sample size was reduced to 99 students because of attrition due to student mobility, schedule conflicts, and student/parent requests to withdraw. A total of 99 (82.5%) students remained in the study. Of these 99 students, eight students had missing data on all of the comprehension measures either at pretest ($n = 1$) or at posttest ($n = 7$) and were excluded from the analyses, which resulted in a total sample of 91 students. There were no statistically significant differences between the two groups on demographics ($\chi^2s < 3.50$, $ps > .06$) or available pretest measures ($Fs < 0.56$, $ps > .45$), nor did the group of 29 students who withdrew or had missing data differ from the full sample on the available measures.

Demographic information collected from the school districts on participating students is summarized in Table 1. The majority of participants were Hispanic (59.34% of the total sample), with Caucasian (26.37% of the total sample) and African American (20.88% of the total sample) students making up most of the final sample. (Some students reported multiple ethnicity identifiers.) Approximately 24% were enrolled in a free or reduced lunch program. Approximately one fourth of the total sample (25.27%) had limited English proficiency according to a criterion outlined by state education guidelines. Of the total sample, 15.38% had special education classification according to school district guidelines. The mean age of participants was 14.9 years ($SD = 0.62$).

There were no statistically significant differences between the intervention and comparison groups on any of the demographic variables (see Table 1).

Intervention teachers

Research staff hired, trained, and supervised three intervention teachers. Two intervention teachers had master's degrees in education and the third had a doctoral degree. All three teachers had experience teaching high school English and had previously provided reading intervention instruction as part of large-scale research studies. All three teachers had more than 5 years of teaching experience.

Procedures

District personnel identified an initial pool of students who had not passed the state accountability reading test, the Texas Assessment of Knowledge and Skills (TAKS; Texas Education Agency, 2004), as seventh graders. Seventh-grade TAKS scores were used as a measure of screening and were the most current data available. The TAKS has been used in previous experimental studies as an initial screener for identifying adolescents with reading difficulties (Vaughn & Fletcher, 2012). All students who had not passed the seventh-grade TAKS were required to participate in reading intervention classes during eighth grade, the same year the screening took place. District personnel requested that the screening take place toward the end of the spring semester of eighth grade so that randomization and class scheduling could occur during the spring semester prior to students' ninth-grade year and the beginning of the research study. The cut scores for identifying participants to include in the study were established with an aim of identifying those students without severe word reading difficulties who had low reading comprehension. Although a portion of the intervention addressed word reading, the primary focus of the study was to improve vocabulary and reading comprehension outcomes. For students to be eligible to participate they had to (a) score a standard score >70 (2 *SD*) on the Test of Word Reading Efficiency (TOWRE) and (b) score a standard score <93 (0.5 *SD*) on the Gates-MacGinitie Reading Comprehension subtest (GM-RT). We included the TOWRE measure to eliminate potential participants with very severe word reading deficits (more than 2 *SD*). No students were excluded as potential participants because of TOWRE scores lower than the established cut score.

The instructional coaches of the research team provided intervention teachers with 16 hr of professional development to prepare them to implement the intervention with fidelity. The instructional coaches both had more than 10 years of experience teaching reading interventions to adolescents, including classroom coaching responsibilities on large-scale group-design reading intervention studies. Professional development covered each of the components of the intervention, including review walk-in slips, essential words, text-based expository reading, chapter book reading, inference reading, and word study fluency. As a means of effectively implementing each component, teachers were trained on methods of explicit instruction, including modeling, think-alouds, examples/nonexamples, and guided and independent practice. Because all of the tutors were relatively experienced in providing reading instruction, we placed more emphasis on the quality of instruction rather than strict adherence to the treatment protocol to provide teachers with some flexibility in implementing the different components. The instructional coaches provided feedback to intervention teachers regarding materials and instruction on a weekly basis through classroom coaching sessions and planning meetings.

The three intervention teachers provided a total of 11 sections of the reading intervention as an elective course across the five high schools. In the larger district, the first intervention teacher taught four sections across two high schools (two each), and the second intervention teacher taught three sections at the third high school. In the smaller district, the third teacher taught four

Table 2. Intervention teacher section assignments.

Interventionist	Urban HS1	Urban HS2	Urban HS3	Rural HS1	Rural HS2
Teacher 1	Two sections	Two sections			
Teacher 2			Three sections		
Teacher 3				Two sections	Two sections

Note. HS: high school.

sections (two each) across the remaining two high schools (see [Table 2](#)). The intervention participants were placed into classes each with approximately five students ($M = 5.1$, $SD = 1.9$) per class. On average students received approximately 114 hr of intervention across two semesters of instruction during their ninth-grade year. In one district students met on a block schedule (90-min sessions, 2–3 days per week), and in the other district students met daily (45-min sessions, 5 days per week). There were no statistically significant differences in intervention dosage across the two districts, $t(27) = 1.48$, $p = .92$. Pretesting of students in both conditions occurred in early September at the start of the school year, and posttesting occurred in late May at the end of the school year.

Description of the intervention

Based on the conceptual framework of the study we designed the intervention to address both sides of the SVR by having components designed to address both word study (e.g., decoding, fluency) and linguistic comprehension. We placed more emphasis on comprehension based on the screening criteria designed to eliminate students with severe word reading issues and to provide supports more closely aligned with the tasks asked of students across their content area courses. The teachers and instructional coaches collaborated in developing the materials for the study, with the instructional coaches taking the lead. After the unit lesson plans were finalized, the instructional materials were distributed to the interventionist with the expectation that he or she follow the lesson plans. The only difference in implementation across the two districts was in how their schedules were organized. Students in the first district received 90-min blocks of instruction two or three times per week, whereas in the second district the students met daily for 45 min. Two sets of lesson plans were developed that mirrored each other in terms of content and components that were reorganized based on the differing time allotments. A sample lesson plan is provided in [Figure 1](#).

The intervention reading materials focused on expository text that covered content associated with social studies and science and high-interest chapter books. Students read passages on the following units: introduction to human geography; Europe, Russia, and Transcaucasia; Africa; energy and cellular transport; cell cycles; meiosis and genetics; and heredity and evolution. The lesson units were designed for 2 weeks of instruction. At the end of each unit, a curriculum-based measure was administered only to students in the intervention. The measure was proximal to the content of the units and was not used as an outcome measure; its purpose was simply to inform teachers' instruction based on students' performance from unit to unit. The core components of each unit included the following: review walk-in slips, essential words, text-based expository reading, chapter book reading, inference reading, and word study fluency. See [Table 3](#) for an overview of the intervention components and [Figure 1](#) for a sample lesson plan.

Review walk-in slips

At the beginning of each session students would start class by independently completing a brief walk-in slip. The purpose of the activity was to provide a brief review of previously taught essential words and have students complete a one-paragraph reading followed by answering a question

Materials for Day 1 Unit 8: Organisms	90 min.
1) Day 1 Walk-in slip, "Natural Selection."	
2) Introduce essential words: variations, Natural Selection	
3) CAL, "Surprise! Cricket Pollinates Rare Orchids" article	
4) "The Gun" chapter book OR Engaging Debate Articles	
5) Word Work Fluency, timers, Unit 8, Does it Make Sense#1	
6) Inference work	

1. Walk-in Slip – 5 minutes

- Read handout, "Natural Selection."
- On walk-in slip, students answer question, "Why are there no more green beetles from the example?"
- Briefly discuss answers, use as a springboard into today's essential words

2. Introduce Essential Words – 10 minutes

- Follow explicit essential words routine for words: **variations, Natural Selection**
- Students recording words and definitions on essential word graphic organizer.
- Use words in student friendly sentences
- Provide sentence starters for students to share sentences as part of class discussion

3. Comprehension Acquisition Log (CAL) – 20 minutes

- Read, "Surprise! Cricket Pollinates Rare Orchids"
- Acquisition Comprehension Log for students – focus on comprehension along with looking for a few unknown words with taking notes.
- Teacher should stop between sections of text and ask students to "Tell me what it's about?" Based on responses, direct students to certain sections of text down to the sentence or word level if necessary to facilitate understanding. *Note: See text-based reading routine.*

5-Minute Break

4. Read Chapter book (no log) – 15 minutes:

Chapter Book

- Read, "Any Small Goodness"
- Teacher should stop between sections of text and ask students to "Tell me what it's about?" Based on responses, direct students to certain sections of text down to the sentence or word level if necessary to facilitate understanding.
- Pull sentences out of text – sometimes change one word, sometimes not: Ask if it makes sense? (yes or no)
- Identify *some* opportunities in text to identify words that can be figured out from context. Teach students how to use context clues.
- **Check for understanding** with Who, What, Where, When, Why, and How questions. Look for opportunities to make connections throughout the story by looking forward and backward.

5. Word Work Fluency – 15 minutes

- Teacher distributes Unit 8 Word Work fluency list #1 or students can work on Word Work Word Pattern Lists #26-55
- Students practice fluency using academic word lists or word pattern lists in partners. Use timers to track fluency.
- Students practice with Unit 8 "Does it Make Sense" statement #1 (12 statements)

5-Minute Break

6. Inference practice – 15 minutes

- Teacher introduces the topic and leads a brief discussion of key terms
- Preview of book and discussion making connections to key terms
- Students read first section of text
- Class discussion with a focus on 'How', 'Why' questions and reading between the lines
- Independent read and partner work on remaining sections
- Discuss answers to partner work
- Wrap-up with summary statement and preview of next reading

Figure 1. Example lesson plan.

designed to serve as a springboard to the content of the readings presented during the core instructional components. Consistent review of material is well supported in the literature as one essential component of intervention instruction (Rosenshine, 2012; Swanson, 1999). This also served as a behavior management exercise by providing students with a reading-related task immediately on entering class.

Table 3. Summary of intervention components (90-min cycle).

Component	Day 1	Day 2	Day 3	Day 4	Day 5
Walk-in slips	5 min	5 min	5 min	5 min	5 min
Essential words	10 min	10 min	10 min	10 min	5 min
Text-based expository reading	20 min	20 min	20 min	20 min	20 min
Break	5 min	5 min	5 min	5 min	5 min
Narrative text	20 min	20 min	20 min	20 min	20 min
Word study fluency	15 min	15 min	25 min	15 min	CBM
Inference reading	15 min	15 min	15 min	15 min	CBM

Note. CBM = curriculum-based measure of essential words and text content at the end of each unit for 30 min.

Essential words

The essential words (five words per unit) instructional routine was based on procedures used in previous studies of vocabulary interventions (Gersten, Baker, Smith-Johnson, Dimino, & Peterson, 2006; Vaughn et al., 2009; Vaughn et al. 2013) Essential word instruction was provided for a total of 80 min during each 2-week unit. During the first session of each unit, each word was introduced with the following explicit instruction routine: instruction with simplified definitions, discussion of visuals and synonyms, and words used in context. After the explicit instruction, students worked with partners to answer turn-and-talk questions and discuss position statements. For the remaining sessions of the unit, review of the vocabulary words was embedded in the walk-in slip activity that took place at the beginning of class. We viewed the direct teaching of key concepts through a variety of modalities (orally, visually) as essential to supporting integration of ideas for deeper understanding (Kintsch, 2004).

Text-based expository reading

Text-based instruction was taught for five 20-min sessions during the 2-week units. High-interest readings that were associated with the content of each unit were utilized for this component. We operationalized high-interest topics as content that was in some way deemed relatable or to have meaning to students and their everyday lives. For example, for the unit on cells there were readings on how regulatory factors malfunction within the cell cycle of cancer and how recent medical advances work to emulate the body's natural process in order to stop the growth of cancer cells.

These readings had the essential words embedded within the texts. Before reading, students previewed the passage by determining their background knowledge on the topic and by making a prediction about what they might learn. During reading, students would read two to four paragraphs of text that were sectioned off appropriately based on the flow of the content. After each section students would be asked to summarize and describe the main ideas by providing evidence from the text to support their answer. Being able to summarize portions of text is necessary prior to students being able to integrate the ideas of the text with other idea units (Kintsch, 2004).

When students were unable to support their answer, the interventionists would ask them to reread and focus on a reduced portion (either multiple sentences or a single sentence) of text that focused on key concepts. If necessary, the interventionist would reduce the focus of the text to identifying a key word in a sentence that represented the key ideas of the section. Interventionists were instructed to always require that students find answers from the text rather than simply through discussion. During reading, students also identified parts of the text where their comprehension broke down, and they were then provided with instruction on how to use context clues to gain understanding of the text. Through teacher prompts and student learning logs students were taught to reread text where the breakdown in understanding occurred and/or reread sentences around that part of the text to gain better understanding.

Narrative text reading

Narrative text reading instruction was taught for five 20-min sessions during the 2-week units. Through whole-group instruction students read chapter books selected by the research team. The books were selected based on stories with plots and storylines about adolescents and their day-to-day struggles; the readability of the text was also taken into account. Anecdotally speaking, the majority of students expressed a high level of interest in the content of these books. For example, one book used for instruction described the plight of a young adolescent boy who moves to the United States from Mexico with his family and the challenges he faces in adapting to a new culture (Johnston, 2001). Students would alternate between partner reading and choral reading. At appropriate stopping points the interventionist would ask students to summarize or list key ideas from the text. The interventionist would also pull sentences out of the text and change a few words and ask students whether the sentence still made sense with the new words. These strategies were designed to facilitate the necessary skills to ultimately integrate idea units from text to support deeper meaning (Kintsch, 2004).

Inference reading

Explicit instruction on the concept of an inference was taught initially at the sentence level. We operationalized inference instruction as opportunities for students to practice making connections both within text and with prior knowledge (Hall, 2016). Instruction included context clues; looking backward, forward, and inside; and reflecting. Students would practice making inferences around questions of who, when, where, and why. When possible, readings from the text-based expository reading and chapter book components were revisited. However, some additional passages were used that aligned with the inference reading instructional routines. This component supported students' ability to understand how idea units and background knowledge come together to form a new and deeper level of understanding (Kintsch, 2004).

Word study fluency

The purpose of this component was to build reading speed, accuracy, and expression. Students practiced fluency with word reading lists. The words used in the lists included variations of the essential words, including synonyms and antonyms (i.e., *organisms* and *species*) and other intermediate to difficult words found in the text-based expository articles. Students worked with a partner to read each list of 20 words with the goal of reading the words in 15 s or less without making errors. The interventionist rotated among pairs checking for accuracy and providing feedback. This component was essential in supporting students' ability to improve in decoding and reading with automaticity as an important mechanism for also supporting improved reading comprehension (Gough & Tunmer, 1986).

Description of the BAU comparison condition

Students assigned to the BAU comparison condition participated in elective classes offered by the district. These course offerings included the following: visual arts, performing arts, audio and video technology, and athletics. We did not have access to data regarding the electives in which students in the control condition chose to enroll. None of the participating high schools offered reading intervention classes for ninth-grade students as an elective or as any other part of the course offerings.

Fidelity of implementation

Intervention teachers audio-recorded all instructional sessions. From the audio recordings, the research team randomly selected one class per school for each intervention teacher to be assigned for fidelity coding. Within each assigned class, three instructional sessions from the beginning, middle, and end of the year were randomly selected. A total of 48 class periods including 56 hr of instruction were coded. Prior to coding, a researcher received a 4-hr training by a senior member of the research team familiar with the intervention. The senior researcher coded instructional sessions that were randomly selected in order to establish a gold standard. After a second researcher coded the same instructional sessions, the researchers met to discuss discrepancies in adherence with the gold-standard method (Gwet, 2001). The process was repeated until comparison of code sheets reached agreement of 90% or higher with the gold standard.

Fidelity was coded for each of the intervention components (see Table 3) using a 4-point Likert-type scale: 1 = low, 2 = mid-low, 3 = mid-high, 4 = high. A score of 4 (high) was assigned when all of the expected elements and procedures were present. A score of 3 (mid-high) was assigned when the majority of the expected elements and procedures were present. A score of 2 (mid-low) was assigned when few of the expected elements and procedures were present. A score of 1 (low) was assigned when the expected elements and procedures were not observed. A score of “not applicable” was assigned when the component was not required or expected during that particular instructional session. The mean implementation score across components and across intervention teachers was 3.07 ($SD = 0.80$, range = 1–4).

We also collected fidelity data related to global observations of the overall quality of instruction, classroom management, and implementation of the intervention. Global observations were rated on a 5-point Likert-type scale: 1 = low, 2 = mid-low, 3 = mid, 4 = mid-high, 5 = high. The score for overall quality of instruction was 3.84 ($SD = 0.98$, range = 2–5). The score for classroom management was 3.76 ($SD = 1.12$, range = 1–5), and the score for implementation of the intervention was 3.74 ($SD = 1.05$, range = 1–5).

Measures

Screening measures

The TOWRE (Torgesen, Wagner, & Rashotte, 1999) consists of two individually administered 45-s subtests of sight word reading and phonemic decoding efficiency. Each list of words and nonwords starts with the least difficult items and gradually increases in difficulty. The alternate-forms reliability coefficients were reported as .91 to .97 (Torgesen et al., 1999).

The GM-RT (MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2007) is a group-administered, norm-referenced reading test. Students were administered on level (7/9, Form S) during screening. In this subtest students are provided with expository and narrative reading passages followed by multiple-choice questions. Questions address the skills of identifying facts from in the passage, discerning vocabulary in context, making near and far inferences, and drawing conclusions. Internal consistency reliability ranges from .91 to .93, and alternate-forms reliability is reported as .80 to .87. Concurrent validity correlations for the GM-RT range from .72 to .87 (Morsy, Kieffer, & Snow, 2010).

Outcome measures

The Test of Silent Reading Efficiency and Comprehension (TOSREC; Wagner, Torgesen, Rashotte, & Pearson, 2010) is a 3-min, group-administered assessment of reading fluency and comprehension. Students are presented with a series of short sentences and asked to read silently and assess whether the sentences are true or false. Average alternate-forms coefficients range from .84 to .95. Validity data have not been reported.

The Woodcock–Johnson III Passage Comprehension subtest (WJ-PC; Woodcock, McGrew, Schrank, & Mather, 2007) consists of 43 items that are individually administered. A passage is presented to the student to read with a portion of the text missing. The student selects a word or phrase for the missing portion that is appropriate given the context of the passage. The items are arranged in order of increasing difficulty. Internal reliability ranges from .80 to .90. Technical documentation of the WJ-PC indicated sound construct and concurrent validity (Woodcock et al., 2007).

The Assessment of Vocabulary in the Content Areas is a researcher-developed measure that consists of two untimed subtests that measure science and social studies vocabulary acquisition. Words included are those frequently found in science and social studies texts. The open-ended subtest consists of 10 short-answer questions in which the student is asked to provide the definition of the underlined word (e.g., “What does morbidity mean?”). Answers receive a score of 0 for no answer or an incorrect answer, 1 for a partially correct answer, and 2 for a full and complete answer. Two scorers independently scored the test protocols prior to comparing answers to determine reliability of scoring. The two scorers had a reliability rating of .98. The multiple-choice subtest consists of 25 items that include a stem with the target word underlined (e.g., “high morbidity”) and five one- to three-word answer choices (e.g., “number of deaths,” “number of attempts”). All words in the short-answer test are included in the multiple-choice test; thus, students were required to complete the former first. This measure followed similar procedures to a separate study of a similar population (Swanson et al., 2016).

Data analysis

Research questions regarding the impact of the intervention on reading comprehension and vocabulary acquisition were addressed through a one between-factor and one within-factor repeated measures design with students randomly assigned in a 2:1 ratio to a reading intervention class or a comparison condition (i.e., an elective class selected by the student).

Effect sizes were calculated using partial eta squared. Partial eta squared is calculated as follows:

$$\eta_p^2 = \frac{SS_{effect}}{SS_{effect} + SS_{error}}$$

Partial eta squared can be understood as the proportion of variance that is attributable to the effect when the variance attributable to all other effects has been removed (Fritz, Morris, & Richler, 2012). Interpretation of partial eta squared depends to some extent on the design of a study, as any variance not attributable to an effect included in the design will become part of the error term in the denominator. Therefore, there is little consensus on one-size-fits-all metrics for interpreting the size of partial eta squared. For the purposes of this analysis, partial eta squared effect sizes are defined as small ($\eta_p^2 = .03$), medium ($\eta_p^2 = .06$), and large ($\eta_p^2 = .10$), as these values are in line with those suggested by Cohen (1988).

Results

A summary of demographic data and descriptive statistics for the pretest word reading and comprehension measures is presented in Table 1. The groups did not differ at pretest, nor did the group of eight eliminated students with missing data on pre- or posttest measures differ on the available measures from the full sample. Students were on average reading at approximately 1 *SD* below the mean compared to the normative population in terms of both word reading and comprehension at pretest.

Table 4. Posttest scores on vocabulary and comprehension measures and effect sizes.

Measure	Comparison		Intervention		Effect sizes		
	<i>M</i> (adjusted)	<i>SD</i>	<i>M</i> (adjusted)	<i>SD</i>	Hedges's <i>g</i>	η_p^2	<i>r</i>
Vocabulary ^a							
Multiple choice	13.80	3.35	17	3.85	.87	.16	
Free response	3.82	2.56	6.70	3.33	.95	.19	
Comprehension ^b							
WJ-PC	75.15 (76.69)	11.57	80.41 (78.21)	11.11	.45	.02	.69
TOSREC	80.33 (80.85)	9.70	85.18 (84.76)	10.81	.46	.04	.46

Note. *r* = correlation between posttest and pretest measures. WJ-PC = Woodcock-Johnson III Passage Comprehension subtest; TOSREC = Test of Silent Reading Efficiency and Comprehension.

^aReported as raw scores. ^bReported as standard scores.

To examine intervention effects, we fit one-way analysis of covariance models on the standardized comprehension measures with the respective pretest scores as covariates. We used one-way analysis of variance of the researcher-developed vocabulary measures, which were administered at posttest, only. We confirmed linear relations between the outcome (posttest) and covariate (pretest) through visual inspection, and Levene's test for equality of variance indicated homogenous variances of outcomes between groups. In addition, the Wald test used to check the equality of correlation matrices detected no difference in slopes between groups. Assumptions about homoscedasticity and the normality of the residuals were met for all models.

We found significant intervention effects on the multiple-choice and free response vocabulary measures: multiple-choice vocabulary measure, $F(1, 89) = 17.28, p = .000, \eta^2 = .16$; free response vocabulary measure, $F(1, 89) = 20.43, p = .000, \eta^2 = .19$. In terms of comprehension, the intervention group performed statistically better than the comparison group on the TOSREC but not on the WJ-PC: TOSREC, $F(1, 88) = 3.92, p = .050, \eta^2 = .04$; WJ-PC, $F(1, 88) = 1.96, p = .165, \eta^2 = .02$. When the Benjamini-Hochberg method (Benjamini & Hochberg, 1995) was applied to correct the critical *p* value to protect against Type I error due to multiple testing, only the two vocabulary measures remained significant at the respecified critical *p* value ($p = .025$). See Table 4 for a summary of the findings.

Discussion

This experimental study examined the effectiveness of a reading intervention on comprehension and vocabulary outcomes of ninth graders with low reading comprehension. Based on findings from our previous work (Solis et al., 2015) we also added a word study component to further support the goal of improved reading comprehension and vocabulary outcomes. Students in the reading intervention were compared to students assigned to a BAU comparison condition. Students in the reading intervention were provided with reading instruction for approximately 114 hr over two semesters. Four repeated measures analyses of covariance were used to test for differences in outcomes between the intervention and BAU conditions.

Findings revealed small effects on one standardized reading measure and no statistically significant effects on another standardized reading measure. Large effects were found on two researcher-developed measures of vocabulary acquisition. These findings reinforce findings from previous studies with younger students that repeated exposure to key vocabulary in the form of simplified definitions, visuals, examples of word use, and opportunities to read about and discuss vocabulary improves students' recall and identification of word meanings (Wanzek & Vaughn, 2007).

The finding of small effects from standardized reading measures is in line with previous research on adolescents with reading problems indicating minimal response to intervention

(Scammacca et al., 2015). The average pretest standard score of participants on one of the standardized measures of reading comprehension was nearly 2 *SD* below that of the normative sample ($WJ\text{-}PC = 74.88$), which indicates a population of students performing several grade levels below their grade placement. With this in mind, it is possible that 1 year of intervention is not enough instructional time for students this far behind to make adequate progress toward remediation of reading comprehension deficits. Students who enter high school with such severe problems may need multiple years of intensive reading intervention as a means of adequately addressing their instructional needs (Vaughn & Fletcher, 2012). Furthermore, it may be that high school students with very low reading scores not only need reading interventions for extended time (over multiple years) but also may need more customized reading interventions. Though we did not have access to data defining the samples with respect to executive functioning variables (e.g., self-regulation, attention, memory), future research may consider how customizing interventions for students to align with their basic reading processes or executive functioning needs might influence their comprehension outcomes.

Research to practice

The findings from this study provide evidence that reading interventions for adolescents with low reading comprehension have the potential to improve vocabulary and comprehension outcomes. Many components of this intervention, such as explicit vocabulary instruction, identifying main ideas, and structured discussion about text, have also been part of other interventions for adolescents (e.g., Barth et al., 2016; Goldman, Snow, & Vaughn, 2016; Swanson et al., 2016; Vaughn et al., 2013). For students with low reading comprehension, practitioners might consider instructional routines that have been associated with improved outcomes, including modeling, opportunities to practice with guided feedback, and independent practice with appropriate instructional scaffolds (Edmonds et al., 2009; Vaughn et al., 2010).

Although providing the reading intervention as an elective with very small groups certainly had its limitations in terms of feasibility, the study supports the notion of secondary settings providing multitiered systems of support. Students receiving additional intervention instruction in reading made statistically significant gains over students in the comparison condition on both standardized and researcher-developed measures. High school administrators should consider how to arrange schedules and course offerings so that students who need additional instruction can be provided with that instruction without losing the opportunity to participate in elective courses.

Limitations and future research

This study provides additional information about the effectiveness of intensive reading interventions for high school students with low reading comprehension. Although the findings support the promise of this area of research, there are important limitations to consider for future research. First, when one assesses a construct as abstract as reading comprehension, issues of measurement quality will limit the study findings. Snow (2003) noted the limited use of standardized measures as a limitation. To address this concern, we included both researcher-developed and standardized measures in the study design. Future research should consider the use of other standardized measures (Snow, 2003) and researcher-developed measures more proximal to the reading instruction.

A second limitation of this study is the small percentage of fidelity of implementation data collected. Future studies should collect a larger percentage of fidelity data for instructional sessions. A third limitation is that the fidelity scores were lower than expected. Although we attempted to balance the implementation of the treatment protocol with some flexibility focused on quality

rather than strict adherence to the protocol, the results from this study indicate the need for improvements to implementation. Future studies should continue to investigate procedures to capture fidelity in terms of both adhering to the protocol and taking into account more global indicators such as overall quality and classroom management.

Many high schools would have difficulty providing enough staff to provide such small instructional groups. Beyond staffing, the requirements of high school are very different from those of elementary or middle school. Once students enter high school they begin to accumulate specific course credits toward graduation. This makes it much more difficult to determine a feasible manner of providing additional reading instruction that is necessary to potentially remediate reading problems.

In this study, the approach to providing this additional time involved asking students to give up an elective course in order to participate in the reading intervention. Intervention teachers anecdotally reported that many students, although willing to participate, were not happy about giving up an elective course of interest. Students lost to attrition also expressed this concern. Although we did not detect statistically significant differences between students who chose to participate and those who chose to drop out of the study, it may be possible that those who dropped out were less motivated or concerned about their reading problems. We acknowledge that giving up a high school elective course is less than ideal, and other approaches should be considered.

Future research should consider an alternative approach for providing interventions, which is to integrate reading interventions within courses that are also designed to meet content area course requirements (i.e., Swanson et al., 2016). We did not collect data on the performance of students with grades in the social studies and science classes that we targeted for vocabulary and reading content within the intervention. This limits the external validity and potential practical significance of the outcomes. Analysis of student performance in terms of course grades and performance on state testing in these subject areas should be considered in future studies. Recent studies including these outcomes have shown the potential promise of intensive reading and learning interventions for having a positive influence on the performance of students participating in the intervention (i.e., Swanson et al., 2016).

Most important, the gap in performance between adolescents with reading problems and their typically performing peers is so wide (Hock et al., 2009) that it is essential that future intervention research at the high school level investigate multiyear interventions. Researchers, administrators, and policymakers need to acknowledge the severity of the problem and the interventions necessary to support this vulnerable population in increasing their literacy level prior to graduating from high school and entering postsecondary education or the workforce.

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